DISCOVERY OF ONE OF THE OLDEST GYMNOSPERM FLORAS CONTAINING CUPULATE SEEDS

Lawrence C. Matten, William S. Lacey, and Dianne Edwards

Department of Botany, Southern Illinois University, Carbondale, Illinois
School of Plant Biology, University College of North Wales, Bangor, Wales
Botany Department, University College of South Wales and Monmouthshire, Cardiff, Wales

Abstract. A number of petrified and compression specimens of stems, fronds, and seeds have been found in the Upper Old Red Sandstone of southwest Ireland. To date, the seeds are the second oldest to be discovered. The seeds, identified as *Hydrasperma*, are cupulate and suggest the possibility that abscission between the seed and its cupulate stalk accounts for non-cupulate remains of this genus.

In 1973, remains of a number of petrified seeds were collected from the Upper Old Red Sandstone of Kerry Head, Ireland (1). The Upper Old Red Sandstone transgresses the Devonian-Mississippian boundary (2) and the seeds are probably lowest Mississippian (Tournaisian) in age. Only one other seed *Archaeosperma arnoldii*, is older than the seeds from Kerry Head (3). Three of the seeds were found attached to cupules and all are referable to a single species, *Hydrasperma tenuis* Long (4). In association with the seeds are petrified remains of stems and fronds of primordial gymnosperms that are referr to the group generally called seed ferns.

The *Hydrasperma* seeds are radiospermic and orthotropous (Fig. 1). The integument is fused to the nucellus up to the level of the plinth forming ridges on the ovular surface. Th eight integument segments are free above the plinth, extendin about 1 mm and not forming a micropyle. The total length of the seed is up to 3.5 mm and the width up to 1 mm.

The cupule of *Hydrasperma* consists of terete dichotomizi axes that appear to be a unit on a larger morphologic entity, perhaps a lateral branch system or megaphyll. The base of th cupule is a single terete axis that dichotomizes at least three times producing eight separate and terete to oval (in transection) lobes. The cupule lobes bear and surround a pai of seeds (Fig. 2).

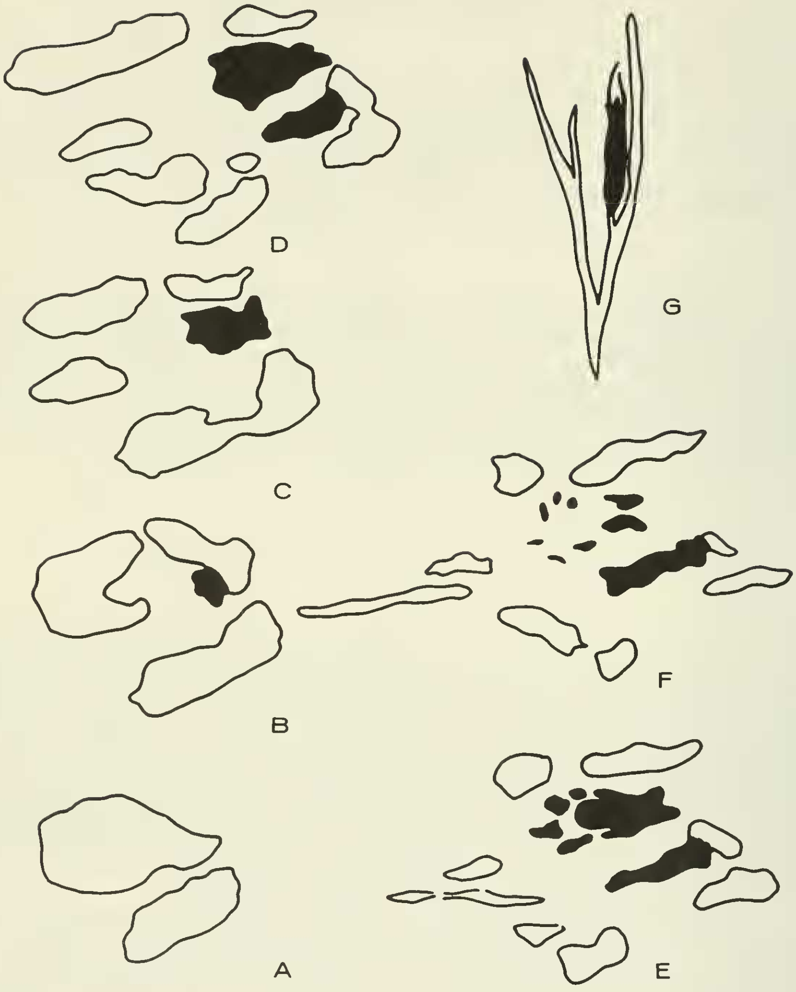

Fig. 1. Hydrasperma tenuis from Kerry Head, Ireland. A-F represent serial transections of a cupulate specimen (Southern Illinois Paleobotanical Collection, B7. 16-21). The darkened portion represents the seeds. G represents a longisection through a cupulate specimen (SIPC B7 ls).

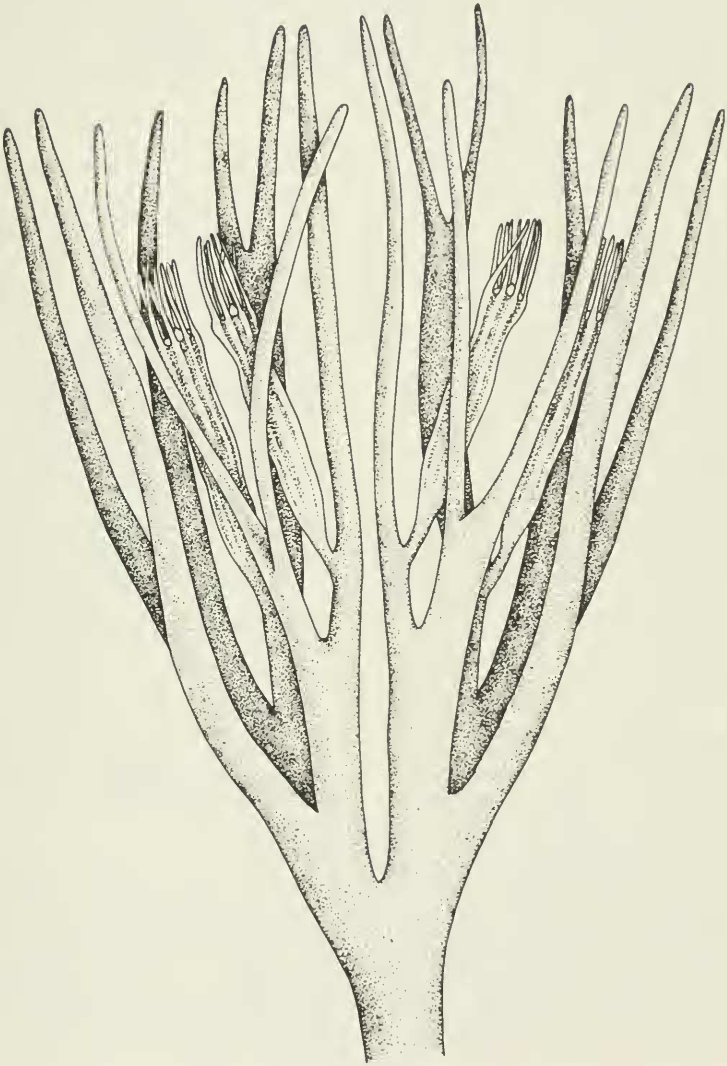

Fig. 2. Reconstruction of cupules of Hydrasperma tenuis.

Besides the oldest seed, Archaeosperma, and Hydrasperma, only nine other structurally preserved species of cupulate seeds are known (5): Gnetopsis elliptica, Lagenostoma lomaxi, Sphaerostoma ovale, Calathospermum scoticum, Tyliosperma orbiculatum, Geminitheca scotica, Calathospermum fimbriatum, Stamnostoma huttonense, and Eurystoma angulare. Of these, Calathospermum has many seeds per cupule, Sphaerostoma, Lagenostoma, and Tyliosperma have one seed per cupule, and Gnetopsis, Stamnostoma, Geminitheca, and Eurystoma have two to four seeds per cupule. In addition, compressions of the oldest seed, Archaeosperma, show two seeds per cupule (6).

Of the three groups of cupulate seeds, the one with two to four seeds per cupule appears to represent the most primitive condition. The oldest seeds (stratigraphically) occur in the group (Archaeosperma, Hydrasperma, Stamnostoma, Eurystoma). The cupular units are generally terete and show little or no fusion of parts. Long (5) interprets the cupule in this group as representing only part of a frond. The evolution of the cupulate seed in this group is thought to have occurred in the following manner: 1) fertile, lateral branch system became overtopped. The lateral branch system consisted of axes branching in several planes. The seed-bearing portion of the system consisted of axes with terminal ovules and sterile units. 2) Accretion of the sterile units around a few ovules (2-4) resulted in early cupular units (Hydrasperma, Eurystoma). 3) Planation (having the cupular units develop at the same level and to the same degree) and some webbing followed (Stamnostoma, Archaeosperma). 4) Parallel to the cupule development was the planation and webbing of the remainder of the lateral branch system to form the frond. The frond thus developed simultaneous with or immediately after the appearance of the cupule. It should be noted that Long (5) interprets the Calathospermum cupule as representing an entire frond. This is not surprising as the contemporaneous development of cupules in several genera probably indicates a polyphyletic origin of this organ.

In addition to the primitive nature of the cupule in Hydrasperma, the seed shows a number of primitive characters. The most obvious is the lack of a definite micropyle. This condition is also present in Genomosperma kidstoni. The presence of free integument lobes above the level of the plinth is a second primitive character.

The occurence of Hydrasperma tenuis seeds without cupules in the Scottish lower Carboniferous leaves several unanswered questions. Is it possible that the Irish cupulate Hydrasperma and the Scottish non-cupulate Hydrasperma are different taxa? If not, did the Hydrasperma seeds have a natural means for dispersal? Such a means would be abscission of the seed stalk. This would help explain the difference between the Irish and Scottish specimens. The possibility of abscission then leads one to the natural question about how many other non-cupulate lower Carboniferous seeds are really the abscissed part of a cupular complex. In our opinion, Genomosperma is a likely candidate.

The petrified seeds from Ireland have thus helped us visualize some of the problems involved in the interpretation of the early evolution of the seed. In addition, the petrified remains of seed fern stems and petioles (now being studied) may help us reconstruct one of the earliest seed plants to inhabit our green Earth.

REFERENCES AND NOTES

1. The impetus for the collecting trip was the find of some petrified remains from this area in the collections of the Royal Scottish Museum. We would like to thank Dr. C.D. Waterston, Department of Geology for the loan of the specimen and for his help during the initial phase of this work.
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